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FIPS PUB 182
FEDERAL INFORMATION PROCESSING STANDARDS PUBLICATION
INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

CATEGORY: TELECOMMUNICATIONS STANDARD
SUBCATEGORY: INTEGRATED SERVICES DIGITAL NETWORK
1993 October 5

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Computer Systems Laboratory
National Institute of Standards and Technology Gaithersburg, MD 20899
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U.S. Department of Commerce Ronald H. Brown, Secretary
Technology Administration
Mary L. Good, Under Secretary for Technology
National Institute of Standards and Technology
Arati Prabhakar, Director

Foreword

The Federal Information Processing Standards Publication Series of the National Institute of Standards and Technology (NIST) is the official publication relating to standards and guidelines adopted and promulgated under the provisions of Section 111 (d) of the Federal Property and Administrative Services Act of 1949 as amended by the Computer Security Act of 1987, Public Law 100-235. These mandates have given the Secretary of Commerce and NIST important responsibilities for improving the utilization and management of computer and related telecommunications systems in the Federal Government. The NIST, through its Computer Systems Laboratory, provides leadership, technical guidance, and coordination of Government efforts in the development of standards and guidelines in these areas.

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James H. Burrows, Director
Computer Systems Laboratory

Abstract

This publication defines the generic protocols necessary to establish transparent Integrated Services Digital Network (ISDN) connection among government networks and between government and conformant common carrier networks. This FIPS provides a minimal set of bearer services, and is based on national standards, international standards, and implementation agreements developed by the North American ISDN Users' Forum (NIUF).

This standard supports a range of integrated services including voice, data, image, and video services. This standard is consistent with Federal Information Processing Standard 146-1, Government Open Systems Interconnection Profile (GOSIP), which provides protocols for computer to computer data communications using ISDN as a lower layer network technology.

Key words: basic rate interface; bearer service; circuit mode; conformance test; customer premises equipment; Federal Information Processing Standard (FIPS); implementation agreements; ISDN; NIUF; packet mode; primary rate interface; terminal adaptation.

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Announcing the Standard for

INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

Federal Information Processing Standards Publications (FIPS PUBS) are issued by the National Institute of Standards and Technology after approval by the Secretary of Commerce pursuant to Section 111 (d) of the Federal Property and Administrative Services Act of 1949 as amended by the Computer Security Act of 1987, Public Law 100-235.

1. Name of Standard. Integrated Services Digital Network (ISDN) (FIPS PUB 182).

2. Category of Standard. Telecommunications Standard; Integrated Services Digital Network.

3. Explanation. This publication defines the generic protocols necessary to establish transparent Integrated Services Digital Network (ISDN) connections among government networks and between government and conformant common carrier networks. This FIPS provides a minimal set of bearer services, and is based on national standards, international standards, and implementation agreements developed by the North American ISDN Users' Forum (NIUF). Future versions of this FIPS will provide protocols for additional services, teleservices and applications.

This standard supports a range of integrated services including voice, data, image, and video services. This standard is consistent with Federal Information Processing Standard 146-1, Government Open Systems Interconnection Profile (GOSIP), which provides protocols for computer to computer data communications using ISDN as a lower layer network technology.

4. Approving Authority. Secretary of Commerce.

5. Maintenance Agency. U. S. Department of Commerce, National Institute of Standards and Technology (NIST), Computer Systems Laboratory.

6. Cross Index. NIST Special Publication 500-195, North American ISDN Users' Forum Agreements on Integrated Services Digital Network (ISDN), September 1991.

7. Related Documents.

- a. Federal Information Resources Management Regulations (FIRMR) subpart 201.20.303, Standards, and subpart 201.39.1002, Federal Standards.
- b. Related documents are listed in the Reference Section of the ISDN document.

8. Objectives. The primary objectives of this standard are:

- to achieve interconnection and interoperability of user and network equipment that are acquired from different manufacturers in an open systems environment;
- to reduce the costs of acquiring user equipment for ISDN services;
- to facilitate the use of advanced technology by the Federal Government;
- to stimulate the development of commercial products compatible with ISDN standards.

9. Specifications. Integrated Services Digital Network (ISDN) (affixed).

10. Applicability. This standard shall be used by Federal agencies for the acquisition of ISDN Customer Premise Equipment (CPE), switches, and ISDN services implementing the protocols specified herein.

11. Implementation. This standard is effective April 15, 1994. Agencies are permitted and encouraged to cite this standard in procurement requests immediately.

This standard shall be cited in solicitations and contracts initiated after April 15, 1994, when the services or products to be acquired provide the functionality specified in this standard, if conformant products and service providing the desired functionality are available, or are expected to be available, for delivery within the terms of the solicitation or contract. An acquisition agency may specify that a procurement request which is based on this FIPS require offerers to provide either evidence of conformance to the ISDN FIPS or to provide explicit evidence of the capability of a migration path towards conformance to the FIPS for the products and services offered in response to the procurement request. Even when conformant products and service provider offerings are not yet available, it is recommended to use this standard to the greatest extent possible, and to follow the recommendations of any subsequent user guidelines to this standard issued by the National Institute of Standards and Technology. In addition, for the indefinite future, agencies will be permitted to buy additional services that are beyond the scope of this standard. The ISDN Conformance Test working group in the NIUF has developed a set of abstract test suites for selected standards and implementation agreements. Test systems implementing these abstract conformance test suites have been developed, or are being developed by testing organizations. As these test systems are complete, NIST will specify the test systems and testing organizations which are accredited to perform conformance testing for this standard.

12. Waivers. Under certain exceptional circumstances, the heads of Federal departments and agencies may approve waivers to Federal Information Processing Standards (FIPS). The head of such agency may redelegate such authority only to a senior official designated pursuant to section 3506(b) of Title 44, U.S. Code. Waivers shall be granted only when:

- a. Compliance with a standard would adversely affect the accomplishment of the mission of an operator of a Federal computer system, or
- b. Cause a major adverse financial impact on the operator which is not offset by Governmentwide savings.

Agency heads may act upon a written waiver request containing the information detailed above. Agency heads may also act without a written waiver request when they determine that conditions for meeting the standard cannot be met. Agency heads may approve waivers only by a written decision which explains the basis on which the agency head made the required finding(s). A copy of each such decision, with procurement sensitive or classified portions clearly identified, shall be sent to: National Institute of Standards and Technology; ATTN: FIPS Waiver Decisions, Technology Building, Room B-154; Gaithersburg, MD 20899.

In addition, notice of each waiver granted and each delegation of authority to approve waivers shall be sent promptly to the Committee on Government Operations of the House of Representatives and the Committee on Governmental Affairs of the Senate and shall be published promptly in the Federal Register.

When the determination on a waiver applies to the procurement of equipment and/or services, a notice of the waiver determination must be published in the Commerce Business Daily as a part of the notice of solicitation for offers of an acquisition or, if the waiver determination is made after that notice is published, by amendment to such notice.

A copy of the waiver, any supporting documents, the document approving the waiver and any supporting and accompanying documents, with such deletions as the agency is authorized and decides to make under 5 U.S.C. Sec. 552(b), shall be part of the procurement documentation and retained by the agency.

13. Special Information. This FIPS encompasses the protocols and implementation agreements for the D channel procedures for the underlying (Layers 1, 2 and 3) ISDN protocols as well as a limited set of other protocols, such as ISDN bearer services, X.25 Packet Services, and Terminal Adaption. Common Channel Signalling-Signalling System #7 protocols are not included.

Where to Obtain Copies. Copies of this publication are for sale by the National Technical Information Service (NTIS), U.S. Department of Commerce, Springfield, VA 22161. When ordering, refer to Federal Information Processing Standards Publication 182 (FIPSPUB182), and title. Specify microfiche if desired. Payment may be made by check, money order, or NTIS deposit account.

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Specification for
INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

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1 GENERAL

1.1 Overview

This Federal Information Processing Standard (FIPS) deals with the generic protocols of the Integrated Services Digital Network (ISDN) necessary to set up transparent "pipes" to provide a minimal set of bearer services. However, it does not address supplementary services, teleservices or applications. Future versions of this FIPS will address additional services and applications. Some special cases of interworking pre-ISDN terminals with ISDN equipment are included.

This standard deals with the generic protocols to support all integrated services and is consistent with Government Open Systems Interconnection Profile (GOSIP). These generic protocols support integration of voice, data, image, and video services. GOSIP Version 2 [NIST 8] only addresses computer data communication as provided by International Telegraph and Telephone Consultative Committee (CCITT) X.31 [CCITT 28] based services of the lower three layer ISDN subnetwork. In this context, GOSIP version 2 only requires a small subset of the ISDN.

1.1.1 Background

The Implementation Agreements (IAs) and Conformance Tests that are referenced in this document were produced by the North American ISDN Users' Forum (NIUF). The NIUF, formed under the auspices of the National Institute of Standards and Technology, has the following mission:

"To create a strong user voice in the implementation of ISDN and ISDN applications and to ensure that the emerging ISDN meets users' application needs."

The NIUF consists of two workshops: the ISDN Users' Workshop (IUW) and the ISDN Implementors' Workshop (IIW). The IUW produces Application Requirements which describe potential applications of ISDN and the features which may be required. The IIW develops Implementation Agreements and Conformance Criteria for American National Standards Institute (ANSI) standard specifications for ISDN, which provide the detailed technical decisions necessary to implement an Application Requirement in an interoperable manner. Attendance at the two workshops of the NIUF encompasses a broad spectrum of the ISDN industry, including ISDN customers, Customer Premises Equipment (CPE) manufacturers, switch manufacturers, interexchange carriers, local exchange carriers, regional bell operating companies, etc.

It is assumed that the reader is familiar with the ANSI standard specifications for ISDN. It is beneficial for the reader to have the following documents available for reference when using this FIPS:

- NIST Special Publication 500-195, North American ISDN Users' Forum Agreements on Integrated Services Digital Networks;

- ANS TL408-1990, Telecommunications-Integrated Services Digital Network (ISDN) -Primary Rate-Customer Installation Metallic Interfaces-Layer 1 Specification;
- ANS TL601-1988, Telecommunications-Integrated Services Digital Network (ISDN)-Basic Access Interface for Use on Metallic Loops for Application on the Network Side of the NT -Layer 1 Specification;
- ANS TL602-1989, Telecommunications-Integrated Services Digital Network (ISDN)-Data-Link Layer Signalling Specification for Application at the User-Network Interface;
- ANS TL603-1990, Telecommunications-Integrated Services Digital Network (ISDN) -Minimal Set of Bearer Services for the Primary Rate Interface;
- ANS TL604-1990, Telecommunications-Integrated Services Digital Network (ISDN) -Minimal Set of Bearer Services for the Basic Rate Interface;
- ANS TL605-1989, Telecommunications-Integrated Services Digital Network (ISDN)-Basic Access Interface at Sand T Reference Points-Layer 1 Specification;
- ANS TL607-1990, Telecommunications-Integrated Services Digital Network (ISDN)-Digital Subscriber Signalling System Number 1 (DSSI)-Layer 3 Signalling Specification for Circuit Switched Bearer Service;
- ANS TL608-1990, Telecommunications-Integrated Services Digital Network (ISDN)-Digital Subscriber Signalling System Number 1 (DSSI)-8signalling Specification for X25 Packet Switched Bearer Service;
- ANS TL612-1990, Telecommunications-Integrated Services Digital Network (ISDN) -Terminal Adaption Using Statistical Multiplexing.

1.1.2 Purpose

Federal agencies will use the ISDN FIPS in procuring ISDN Customer Premise Equipment (CPE), switches, and ISDN services implementing the protocols specified herein. Transparency between government networks, as well as between government and common carrier networks which comply with this standard, is provided for by the standard. In addition, the ISDN FIPS can be used for procurement specifications by any organization.

1.1.3 Scope

The ISDN FIPS is comprised of the protocols, Implementation Agreements and conformance tests regarding the D-channel procedures for the underlying (Layers 1, 2, and 3) ISDN protocols, as well as a limited set of other protocols, such as ISDN Bearer Services, X.25 Packet Services, and Terminal Adaption.

ISDN supplementary services are currently not addressed, but will be added in future revisions to the FIPS.

This document does not include the Common Channel Signalling-Signalling System #7 protocols.

1.1.4 Evolution of this Document

New versions of the ISDN FIPS will be issued as progress is made in developing Implementation Agreements in the NIUF. Each new version will supersede preceding versions, as new versions will include all of the unchanged agreements from previous versions. Additionally, it is expected that each new version will be compatible with previous versions, except in cases of changes due to errors, and changes that are necessary for alignment with ANSI standards activities.

Appendices A, B, and C to this document describe the current status of the NIUF's ongoing effort to develop Implementation Agreements and conformance testing and requirements. These appendices are for information only, and are not part of this document. Appendix D defines the Implementation Agreement for Circuit Mode Data Terminal Adaption, and is a part of the ISDN FIPS.

1.2 Architecture and Model

Similar to GOSIP [NIST 8], achieving ISDN within the government is accomplished by adopting standards applicable to each of the lower three layers of the Open System Interconnection Reference Model. For specifying an ISDN and its protocols, only the network access layers, 1, 2, and 3 are necessary. Layers 4 through 7 utilize these lower three layers for their network requirements for information exchange.

1.2.1 ISDN Reference Configurations

This document uses the reference configuration concepts, functional groupings and reference points as defined in the International Telegraph and Telephone Consultative Committee (CCITT) Recommendation 1.411 [CCITT 14]. Figure I illustrates the basic reference configurations for ISDN user-network interfaces. These reference configurations have been used both in specifying a particular interface configuration in the implementors agreements, and in describing the testing configurations. The functional groups are sets of functions which may be needed in ISDN user access arrangements. These include the Exchange Termination (ET) group, the Network Termination (NT1 and NT2) Group, Terminal Equipment of type 1 (TE1), Terminal Equipment of type 2 (TE2), and Terminal Adapters (TA). The TE1 functional group refers to ISDN Terminals, whereas the TE2 functional group represents the existing non-ISDN terminals, both voice and non-voice. The NT1 and NT2 groups could be considered as either network-side or user-side equipment.

Figure 1. ISDN Interface Functional Groups and Reference Points (not available online)

1.2.2 Basic Architectural Model of an ISDN

Figure 2 [CCITT 8] illustrates the basic capabilities of ISDNs. This FIPS concentrates on the User-network signalling aspects. However, the underlying network capabilities must

be available in order for the "connections" to be made to the "other side" of the network. Figure 2 shows the main switching and signalling functional capabilities of an ISDN:

- non-switched functional entities at rates greater than 64 kbit/s;
- switched functional entities at rates greater than 64 kbps;
- narrow-band (64 kbps) circuit non-switched functional entities;
- narrow-band (64 kbps) circuit switching functional entities;
- packet switching functional entities; and
- common channel inter-exchange signalling functional entities.

These components need not be provided by distinct networks, but may be combined as appropriate for a particular implementation.

Figure 2. Basic Architectural Model of an ISDN (not available online)

1.2.3 Interface Structures

The narrowband ISDN user-network interfaces are generally divided into either basic rate interface (BRI) or primary rate interface (PRI), as defined in CCITT 1.412 [CCITT 16]. The basic rate interface structure is composed of two 64 kbps B-channels and one 16 kbps D-channel (2 B + D), and primary rate interface is composed of either 23 64 kbps B-channels and one 64 kbps D-channel (23 B + D) or 30 64 kbps B-channels and one 64 kbps D-channel (30 B + D). For primary rate, only the 23 B + D interface is addressed in this FIPS; the 30 B + D is outside of the scope of this FIPS.

1.2.4 Implementation Configurations

The ISDN architecture is intended to interconnect all user and network equipments, in a ubiquitous fashion, to provide a common network encompassing all possible communication scenarios. Because of this broad scope, the national standards for ISDN could not be universally applied to all the conceivable combinations of equipment types, access arrangements and applications. For example, implementation of all of the standards would result in unused functionality in a simple terminal device. This is clearly unwarranted in economic terms and equipment complexity. The concept of implementation configurations is introduced to allow specific ISDN capabilities (procedures) to be associated with a class of equipment, an access arrangement, or an application.

The concept of equipment classes is introduced in this document to permit certain procedures to be associated with a particular application or class of equipment, e.g., station equipment versus PBX. Specifically, two classes of equipment, Class I and Class II, are defined on the basis of two fundamental attributes.

The first attribute relates to the possibility of an exchange of signals occurring beyond the public network's point of contact with the interface (i.e., between the equipment directly connected to the public network and ISDN terminals or telephones connected to that

equipment). For example, some user equipment may support subtending Basic Access digital subscriber loops and/or analog telephone loops.

The second attribute relates to the manner in which a SETUP message, the message which initiates an ISDN call, should be presented to the user equipment.

Using these two attributes, Class I equipment (see Figure 3, Figure 4) is specified when the network makes no provision for exchange of signals occurring beyond the public network's point of contact with the interface. When an interface is associated with Class I equipment, it is assumed that multiple pieces of equipment may exist and communicate with the network over the D-channel. However, in this case, all equipment is assumed to be ISDN-capable and is considered as the endpoint of the communication. Therefore, interworking notification should not be accepted from Class I equipment. In addition, when Class I equipment is applied on a particular interface, the network should broadcast the SETUP message associated with each call that terminates on that interface, since interaction between the network and multiple pieces of user equipment should be supported.

Figure 3. Implementation Configurations (not available online)

Figure 4. Examples of Class I Equipment (not available online)

Conversely, in the case of Class II equipment (see Figure 3, Figure 5), the procedures at the network take into account that communication between Class II equipment (with which it communicates directly) and other equipment (with which the network does not have direct contact) may occur. As an example, Class II equipment may support digital and/or analog subscriber loops. Use of Class II equipment also involves the possibility of having interworking occur beyond the equipment with which the network has direct contact. Therefore, it is reasonable for Class II equipment to provide the network with an interworking notification, for both outgoing and incoming calls, when either the calling or called party respectively, is a non-ISDN user. Class II equipment may also send an interworking notification if a private network exists beyond the Class II equipment and interworking to a non-ISDN facility within that network takes place. With relation to the second attribute, the network should not broadcast SETUP messages associated with terminating calls to an interface on which Class II equipment is being used. Here, a single piece of user equipment is assumed to be involved in all communication with the network.

Figure 5. Examples of Class II Equipment (not available online)

To the extent possible, it is desirable to have one set of requirements for ISDN call control apply to all ISDN user configurations. However, in cases for which integrated procedures are not appropriate, the call control procedures associated with Equipment Class I will differ from those associated with Equipment Class II. Unless otherwise noted, the assumption should be that a particular procedure/capability should be provided for both classes of equipment on both basic and primary rate access. However, use of the equipment class terminology permits clarification of the circumstances under which a

certain capability should be available (i.e., when a particular equipment class is in use). It also permits a mechanism for indicating that a particular capability applies only to a subset of four possible configurations: Class I/BRI, Class IIIBRI, Class I/PRI, and Class IIIPRI.

This notation is used within this document to indicate when protocol or procedures are only expected to be supported for a particular class and/or are limited to a particular type of interface, i.e., basic or primary rate interface. These implementation configurations, have, to date, been applied to the Layer 3 circuit switched signalling protocols only.

2 PROTOCOL SPECIFICATIONS

The following paragraphs briefly describe the general functionality of the protocol layers for ISDN.

The Physical layer (layer 1) covers the physical interface between devices. It provides the following functions: encoding of digital data for transmission across the interface, full-duplex transmission of D-channel data, full-duplex transmission of D-channel data, multiplexing of channels into basic or primary access configurations, activation/deactivation of physical circuits, etc.

The Data Link layer (layer 2) covers the reliability functions for the physical layer and provides the means to activate, maintain, and deactivate the link. Link Access Procedures on the D-channel, LAPD [CCITT 22], specifies the protocol for ISDN layer 2 signalling. The purpose of LAPD is to convey information between layer 3 entities across the ISDN user-network interface using the D-channel. LAPD is independent of transmission bit rate. It requires a duplex, bit transparent D-channel.

The Network layer (layer 3) provides the transparent transfer of data between the transport entities. It is responsible for establishing, maintaining, and terminating connections across communications facilities.

The following sections define the standards and NIUF Agreements that shall be used to implement Layers 1, 2, and 3 of an ISDN. The primary focus of these sections is network signalling via the D-Channel.

2.1 Layer 1

The Layer 1 ISDN standards were developed based on the Basic Rate Interface (BRI) and the Primary Rate Interface (PRI) and are further classified according to specific reference points of application. These reference points, S, T, and U specifically, provide the user and network interfaces for TE and NT equipments, as displayed in Figure 1. Unless NIUF Agreements are explicitly referenced, implementation in accordance with the referenced standard is always intended.

2.1.1 Basic Rate Interface

In the case of the Layer 1 BRI, the following standards and agreements shall apply:

2.1.1.1 The network side of the NT consisting of the U reference point, as defined in ANS T1.601-1988 [ANSI 3], shall be implemented in accordance with Section 4.1.1.1 of the NIUF Agreements [NIST 1; NIUF 1]. (Note: When the NIUF Agreements document and the NIUF Implementation Agreements documents are referenced together, the latter are included for reference purposes only, the complete set of documents can be found in their entirety in [NIST 1].)

2.1.1.2 The ISDN Basic Rate Interface for S and T reference points, as defined in ANS T1.605-1989 [ANSI 7], shall be implemented in accordance with Section 4.1.1.2 of the NIUF Agreements [NIST 1; NIUF 2].

2.1.2 Primary Rate Interface

2.1.2.1 The ISDN Primary Rate Interface at the U reference point, shall be implemented in accordance with ANS T1.408-1990 [ANSI 2].

2.1.2.2 Additional Requirements

2.1.2.2.1 The only recognized line code shall be Bipolar with 8 Zero Substitution (B8ZS).

2.2 Layer 2

The ISDN Basic Rate Interface (BRI) and Primary Rate Interface (PRI) access arrangements are specified in a single NIUF Implementation Agreement for the D-channel Layer 2 data link. Layer 2 BRI and PRI, as defined in ANS T1.602-1989 [ANSI 4; CCITT 21, 22] shall be implemented in accordance with Section 4.1.3 of the NIUF Agreements [NIST 1; NIUF 3].

2.3 Layer 3

The ISDN BRI and PRI access arrangements will utilize the Layer 3 Signalling protocol as defined by ANS T1.607-1990 and T1.608-1990 [ANSI 8,9]. These specifications apply to two distinct connection types: circuit switched and packet switched.

2.3.1 The Layer 3 signalling protocol for Circuit Switched bearer services shall be responsible for the establishment, maintenance and tear-down of basic signalling connections and supplementary service signalling connections which utilize circuit switched access.

2.3.1.1 Basic Call Control Procedures, as defined in ANS T1.607-1990 [ANSI 8, 1; CCITT 9, 10, 11, 12, 13, 23,24,25] shall be implemented in accordance with Section 4.1.4.1.1 of the NIUF Agreements [NIST 1; NIUF 4, 5] as detailed in the following

sections.

2.3.1.1.1 The procedures for Class I BRI Minimal set of Circuit Switched Bearer Services include: Circuit Mode Digital, Circuit Mode Speech, and Circuit Mode Voiceband Data. These services shall be implemented as specified in ANS T1.607-1990 [ANSI 8] in accordance with Section 4.1.4.1.1 of the NIUF Agreements [NIST 1; NIUF 4].

2.3.1.1.2 The procedures for Class II PRI Minimal set of Circuit Switched Bearer Services include: Circuit Mode Digital, Circuit Mode Speech, and Circuit Mode Voiceband Data. These services shall be implemented as specified in ANS T1.607-1990 [ANSI 8] in accordance with Section 4.1.4.1.1 of the NIUF Agreements [NIST 1; NIUF 5], with the exception of Annex D of NIU 90-302 [NIUF 5]. The procedures specified in Annex D, "Extensions for symmetric call operation," are excluded from this FIPS.

2.3.2 The Layer 3 signalling protocol for X.25 Packet Switched bearer services shall be responsible for the establishment, maintenance and tear-down of basic signalling connections and supplementary service signalling connections which utilize packet switched access. These services shall be implemented as specified in ANS T1.608-1990 [ANSI 9].

3 SERVICES SPECIFICATION

3.1 Bearer Services

The minimal set of bearer services as defined in ANS T1.604-1990 [ANSI 6] for ISDN basic rate interface, and ANS T1.603-1990 [ANSI 5] for primary rate interface, shall be supported. The bearer services defined in these standards are the minimal set of bearer services which are to be supported by public networks for ISDN basic rate and primary rate interfaces. These bearer services conform closely to CCITT architectural concepts and describe the constraints in the USA telecommunications environment for the ISDN basic and primary rate interfaces. This FIPS does not preclude the implementation of additional bearer services.

Although this FIPS does not specify terminal initialization procedures for bearer services, implementors and equipment specifiers using this FIPS as a guide to government procurement should be cautioned that terminal equipment is required to use initialization procedures specified in current network specifications which the Regional Bell Operating Companies (RBOCs) and major network equipment vendors have agreed to support in their initial offering of ISDN capability.

3.1.1 Circuit Mode

3.1.1.1 Circuit Mode Digital

The Circuit Mode Digital Bearer Service shall be implemented in accordance with ANS T1.604-1990 and ANS T1.603-1990 [ANSI 6, 5], for BRI and PRI, respectively. This

bearer service is defined as 64 kbps transfer rate, with 8 kHz integrity structure, and unrestricted digital transfer capability.

The following service definitions describe how the service will be used. According to ANS T1.603-1990 [ANSI 7], "For this circuit mode digital bearer service with capability attribute value 'unrestricted,' the essential characteristic is that the received bit stream is identical (within performance limitations) to the transmitted stream including network provided octet framing at the user-network interface. Mu-Law to A-law conversions would not be provided at the internetwork points between mu-Law and A-law countries. The actual application is controlled by user equipment at each end and could thus, in principle, transport voice, rate adapted and non-rate-adapted circuit mode data, packet-mode data, and the like."

3.1.1.2 Circuit Mode Speech

The Circuit Mode Speech Bearer Service shall be implemented in accordance with ANS T1.604-1990 and ANS T1.603-1990 [ANSI 6, 5], for BRI and PRI, respectively. This bearer service is defined as 64 kbps transfer rate, with 8 kHz integrity structure, and speech transfer capability.

The following service definitions describe how the service will be used. According to ANS T1.604-1990 [ANSI 8], "for the speech bearer service, the network assumes that mu-Law encoded speech CCITT Recommendation G.711 [CCITT I], is present at the user-network interface. The network provides octet framing at the user-network interface. The essential characteristic here is that the ISDN may employ processing techniques appropriate for speech which do not assure bit integrity. Mu-Law to A-law conversion would be provided, as appropriate, between networks. Performance of voiceband modems is not guaranteed."

3.1.1.3 Circuit Mode Voiceband Data

The Circuit Mode Voiceband Data Bearer Service shall be implemented in accordance with ANS T1.604-1990 and ANS T1.603-1990 [ANSI 6, 5], for BRI and PRI, respectively. This bearer service is defined as 64 kbps transfer rate, with 8 kHz integrity structure, and 3.1 kHz audio transfer capability.

The following service definitions describe how the service will be used. According to ANS T1.603-1990 [ANSI 7], "for the 3.1 kHz audio bearer service, the network assumes that mu-law encoded, band-limited, audio information is present at the user-network interface. The use of voice band modems, including those specified in the V Series, and group I, II, and III facsimile is intended. The network provides octet framing at the user network interface. Mu-law to A-law conversion may be provided as appropriate between networks. Thus, bit integrity is not assured."

3.1.2 Packet Mode Data

The Packet Mode Data Bearer Service shall be implemented in accordance with ANS T1.604-1990 [ANSI 6], for BRI. This bearer service provides transfer of user information in a packetized manner over a virtual circuit within a B or D-channel at the S/T/U Reference point.

3.1.3 Additional Requirements

3.1.3.1 Subscription options must include:

- 1). the ability for fixed assignment of bearer services to B-channels (determined at subscription time); and
- 2). the ability for dynamic assignment of bearer services to B-channels (determined at access time); e.g., if a B-Channel is idle and the bearer service is from the minimal set supported, then the call can not be refused because the bearer service is not associated with the idle B-channel.

3.2 ISDN Terminal Adaption Specification

The ISDN Terminal Adaption specifications define the requirements for attaching a non-ISDN terminal to an ISDN. This attachment is performed across the R reference point, with the specification of the R reference point providing the necessary characteristics, attributes and functions such that successful interoperability between the non-ISDN and the ISDN is achieved. The IAs developed for terminal adaption provide a specification of the R reference point requirements.

Circuit Mode Data Terminal Adaption, as defined in ANS T1.612-1990 [ANSI 11], shall be implemented in accordance with Appendix D of this ISDN FIPS.

3.3 X.25 Packet Mode Procedures

Circuit mode digital or packet mode bearer services can be used to provide X.25 services. The procedures for using these bearer services are defined in accordance with ANS T1.608-1990 [ANSI 9], Section 7. The applicable protocol stacks for X.25 packet transfer shall be implemented based upon the "Stable Implementation Agreements for Open Systems Interconnection (OSI) Protocols" [NIST 9] from the NIST Workshop for Implementors of OS I, as specified in Section 4.1.4.2 of the NIUF Agreements [NIST 1]. The following sections provide additional requirements.

3.3.1 Wherever X.25 Layer 2 (Link Access Procedures Balanced (LAPB» and Layer 3 (X.25 Packet Layer Protocol (PLP» protocols are referenced in NIUF Agreements, Section 4.1.4.2 [NIST 1], FIPS 100-1 [NIST 7] shall apply.

3.3.2 FIPS 100-1 shall apply to X.25 terminals connected at the R reference point to a Terminal Adapter (TA). In this case the X.25 terminal shall be the Data Terminal Equipment (DTE), and the TA shall be the Data Circuit- Terminating Equipment (DCE).

3.3.3 For Layer 2:

- 1) support for the Multilink Procedure is excluded;
- 2) if the ISDN provides a circuit mode service between two ISDN packet-mode devices, then the layer 2 address shall be assigned as follows:
 - a) For permanent ("non-switched") circuit mode service, one terminal uses address A and the other terminal uses address B, as arranged by prior agreement;
 - b) For demand ("switched") circuit mode service, the terminal originating the circuit mode call uses address A and the other terminal uses address B.

3.3.4 For Layer 3 Packet, the maximum size of the User Data Field in a DATA packet for virtual circuit over the D-Channel shall be limited to 256 octets.

4 CONFORMANCE TESTING REQUIREMENTS

Conformance testing is the process of determining whether an implementation of a protocol complies with the specification of the protocol standard and exhibits behaviors mandated by the standard or Implementation Agreement. For the purposes of testing conformance to a specific requirement of the NIUF, a set of abstract test suites was developed by the ISDN Conformance Test (ICOT) working group in the NIUF, for specific standards and implementors' agreements. These abstract test suites are listed in Section 4.2 of this FIPS.

Test systems implementing these abstract conformance test suites have been developed, or are being developed, by testing organizations. When these have been completed, NIST will specify the test systems and testing organizations which are accredited to perform conformance testing of the ISDN FIPS compliancy. In the interim, the Acquisition Authority, or agency, may specify its own requirements for conformance testing and test systems, and may require a statement of conformance from the vendor.

4.1 Development of NIUF Conformance Test Suites

The ISDN Conformance Testing (ICOT) group of the NIUF has been developing conformance test suites for the protocol standards for ISDN layers 1,2, and 3. Separate test suites for the user [and network side equipment], and for the Basic Rate Interface (BRI) and Primary Rate Interface (PRI). Figure 1 shows the model of functional groups and reference points across a basic rate interface.

Conformance testing is divided into smaller groups by protocol layers-the Physical Layer (Layer 1) at the SIT [ANSI 2, 7; CCITT 16, 17] and U [ANSI 2, 3] reference points, the Data Link Layer (Layer 2) [ANSI 4; CCITT 22], and the Network Layer (Layer 3) [ANSI 8, 9; CCITT 24, 27]. In addition, grouping by type of services (bearer circuit switching, bearer packet switching, supplementary services, etc.), and type of interfaces (basic rate access and primary rate access) is necessary.

4.2 Specification of Abstract Test Suites for NIUF Compliancy

The following sections specify the abstract test suites which have been completed by the NIUF, and which shall be implemented to test ISDN equipment for compliance with ISDN protocol standards and agreements reached in the NIUF. Appendix C lists the other test specifications for ISDN Layer 1, 2, and 3 standards, as well as, additional test specifications for supplementary services, terminal adapter, and packet mode bearer services which have not yet completed the NIUF process.

The abstract test suites specified in this FIPS are listed below. These abstract test suites will be published separately in NIST Special Publications on ISDN Conformance Testing. Included here are brief descriptions of the test specifications and test configurations for ISDN layers 1, 2, and 3 as developed in the NIUF.

4.2.1 General

Overview of ISDN Conformance Testing [NIST 6] provides an overview of the current status of ISDN Conformance Testing, and the issues involved.

4.2.2 Physical Layer Test Specifications

Layer 1 -Physical Layer describes the test specifications for ANS T1.605-1989 [ANSI 7], ANS T1.601-1988 [ANSI 3] and ANS T1.408-1990 [ANSI 2]. This includes testing of functional, electrical, and mechanical characteristics of devices including TE1, TA, and NT's on the user side. The tests may include verification of framing, line bit rate, relative bit positions, D-channel access control, checking of jitter and phase, impedance, pulse shape and amplitude, pulse balance, receiver/transmitter performance, and power feeding and consumption, start-up procedures, pulse characteristics, frame structure, M-channel bit functions, etc.

Part I: Basic Rate SIT Interface, User Side [NIST 2, NIUF 8] describes a set of test specifications which shall be implemented to verify conformance of TEs and NTs to the ISDN Physical Layer Basic Access at the SIT reference point, as defined in ANS T1.605-1989 [ANSI 7], and NIU 89-105 [NIST I, NIUF 2].

Part 2: Basic Rate U Interface, User Side [NIST 3, NIUF 10] describes a set of test specifications which shall be implemented to verify equipment implementation conformance to the ISDN Physical Layer Basic Access at the U interface, as defined in ANS T1.601-1988 [ANSI 3] and NIU 89-101 [NIST I, NIUF I].

4.2.3 Data Link Layer Test Specifications

Layer 2-Data Link Layer covers the protocol states defined in ANSI T1.602-1989 [ANSI 4] and the CCITT Recommendation Q.921 [CCITT 22]. For each state, three types of tests are specified: valid tests which cover the exchange of valid frames; inopportune tests which check the response of the Implementation Under Test (IUT) to correctly

formatted frames received in an unexpected state; and the invalid tests which verify the IUT's error recovery procedures upon receiving an incorrectly formatted frame.

Part I: Basic Rate Interface, User Side [NIST 4, NIUF 11] defines the abstract test specifications which shall be implemented to verify equipment implementation conformance to the Layer 2 of an ISDN at the user-network interface, for the BRI access arrangements, as defined in ANS T1.602-1989 [ANSI 4] and NIU 89-210 [NIST I, NIUF 3].

4.2.4 Network Layer Test Specifications

Layer 3-Network Access Layer is based upon ANSI T1.607-1990 [ANSI 8] and CCITT Recommendation Q.931 [CCITT 24] and covers the D-channel operations for user-side states in the following functional areas: call setup from user and network, call clearing from user and network, and error recovery mechanisms (invalid information element and missing mandatory information element). As in the Layer 2 test suites, valid, inopportune, and invalid tests are performed. Note that the operations of the B channels are not covered in these tests.

Part I: Basic Rate Interface Circuit Switch Call Control. User Side [NIST 5, NIUF 12] defines the abstract test specifications which shall be implemented to verify equipment implementation conformance to the Layer 3 of an ISDN BRI at the user-network interface for the Basic Call Control Procedures, as defined by ANS T1.607-1990 [ANSI 8], NIU 90-301 [NIST I, NIUF 4], and other corresponding NIUF Implementation Agreements.

Part 2: Primary Rate Interface Circuit Switch Call Control. User Side [NIST 10, NIUF 13] defines the abstract test specifications which shall be implemented to verify equipment implementation conformance to the Layer 3 of an ISDN PRI at the user-network interface for the Basic Call Control Procedures,¹ as defined by ANS T1.607-1990 [ANSI 8], NIU 90-302 [NIST I, NIUF 5].

5 REFERENCES

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2. NIST Special Publication 500-194, ISDN Conformance Testing Layer I-Physical Layer-Part 1 Basic Rate SIT Interface, User Side, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, October 1991, (NTIS Order Number PB92-102201).

3. NIST Special Publication 823-2, ISDN Conformance Testing Layer I-Physical Layer-Part 2 Basic Rate U Interface, User Side, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, October 1991, (NTIS Order Number PB92-181114).
4. NIST Special Publication, ISDN Conformance Testing Layer 2-Data Link Layer-Part 1 Basic Rate Interface, User Side, (NIST SP 823-4).
5. NIST Special Publication, ISDN Conformance Testing Layer 3-Network Layer-Part 1 Basic Call Control Procedures, Basic Rate Interface/Class I, User Side, to be published.
6. NIST Special Publication 823-1, Overview of ISDN Conformance Testing, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, October 1991, (NTIS Order Number PB92-181015).
7. FIPS 100-1, Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) For Operation with Packet Switched Data Networks (PSDN), or Between Two DTE's, by Dedicated Circuit, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, 1989.
8. FIPS 146-1, Government Open Systems Interconnection Profile (GOSIP), NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, 1991.
9. NIST Special Publication 500-183, Stable Implementation Agreements for Open Systems Interconnection Protocols, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, Version 4, Edition 1, December 1990.
10. NIST Special Publication, ISDN Conformance Testing Layer 3-Network Layer-Part 2 Basic Call Control Procedures, Primary Rate Interface/Class II User Side, to be published.

American National Standards Institute (ANSI documents can be obtained by contacting the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

1. ANS T1.218-1991, ISDN Management-Data Link and Network Layers.
2. ANS T1A08-1990, Telecommunications-Integrated Services Digital Network (ISDN)-Primary Rate -Customer Installation Metallic Interfaces-Layer 1 Specification.
3. ANS T1.601-1988, Telecommunications-Integrated Services Digital Network (ISDN)-Basic Access Interface for Use on Metallic Loops for Application on the Network Side of the NT-Layer 1 Specification.
4. ANS T1.602-1989, Telecommunications-Integrated Services Digital Network (ISDN)-Data-Link Layer Signalling Specification for Application at the User-Network Interface.

5. ANS TI.603-1990, Telecommunications-Integrated Services Digital Network (ISDN)-Minimal Set of Bearer Services for the Primary Rate Interface.
6. ANS TI.604-1990, Telecommunications-Integrated Services Digital Network (ISDN)-Minimal Set of Bearer Services for the Basic Rate Interface.
7. ANS TI.605-1989, Telecommunications-Integrated Services Digital Network (ISDN)-Basic Access Interface at Sand T Reference Points-Layer 1 Specification.
8. ANS TI.607-1990, Telecommunications-Integrated Services Digital Network (ISDN)-Digital Subscriber Signalling System Number 1 (DSS1)-Layer 3 Signalling Specification for Circuit Switched Bearer Service.
9. ANS TI.608-1990, Telecommunications-Integrated Services Digital Network (ISDN)-Digital Subscriber Signalling System Number 1 (DSS1)--Signalling Specification for X25 Packet Switched Bearer Service.
10. ANS TI.610-1990, Telecommunications-Integrated Services Digital Network (ISDN)-Digital Subscriber Signalling System Number 1 (DSS1)-Generic Procedures for the Control of ISDN Supplementary Services.
11. ANS TI.612-1990, Telecommunications-Integrated Services Digital Network (ISDN)-Terminal Adaption Using Statistical Multiplexing.
12. ANS TI.613-1990, Telecommunications-Digital Subscriber Signalling System No.1 (DSS1)-ISDN Call Waiting.

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2. CCITT Recommendation 1.251, Number Identification Supplementary Services.
3. CCITT Recommendation 1.252, Call Offering Supplementary Services.
4. CCITT Recommendation 1.253, Call Completion Supplementary Services.
5. CCITT Recommendation 1.254, Multiparty Supplementary Services.
6. CCITT Recommendation 1.255, Community of Interest Supplementary Services.
7. CCITT Recommendation 1.256, Charging Supplementary Services.

8. CCITT Recommendation 1.324, ISDN Network Architecture.
9. CCITT Recommendation 1.330, ISDN Numbering and Addressing Principles.
10. CCITT Recommendation 1.331, Numbering Plan for the ISDN Area.
11. CCITT Recommendation 1.332, Numbering Principles for Interworking Between ISDNs and Dedicated Networks With Different Numbering Plans.
12. CCITT Recommendation 1.333, Terminal Selection in ISDN.
13. CCITT Recommendation 1.334, Principles Relating ISDN Numbers/Subaddresses to the OSI Reference Model Network Layer Addresses.
14. CCITT Recommendation 1.411, ISDN User-Network Interfaces-Reference Configurations.
15. CCITT Recommendation 1.412, ISDN User-Network Interfaces-Interface Structures and Access Capabilities.
16. CCITT Recommendation 1.430, Basic User-Network Interface Layer 1 Specification.
17. CCITT Recommendation 1.431, Primary Rate User-Network Interface Layer 1 Specification.
18. CCITT Recommendation 1.460, Multiplexing, Rate Adaption and Support of Existing Interfaces.
19. CCITT Recommendation 1.464, Multiplexing, Rate Adaption and Support of Existing Interfaces for Restricted 64 kbps Transfer Capability.
20. CCITT Recommendation 1.465, Support By An ISDN of Data Terminal Equipment With V-Series Type Interfaces With Provision For Statistical Multiplexing.
21. CCITT Recommendation Q.920, ISDN User-Network Interface-Data Link Layer-General Aspects.
22. CCITT Recommendation Q.921, ISDN User-Network Interface-Data Link Layer-Specification.
23. CCITT Recommendation Q.930, ISDN User-Network Interface-Layer 3-General Aspects.
24. CCITT Recommendation Q.931, ISDN User-Network Interface-Layer 3-Specification for Basic Call Control.

25. CCITT Recommendation Q.940, ISDN User-Network Interface Protocol for Management-General Aspects.

26. CCITT Recommendation V.120, Support by an ISDN of Data Terminal Equipment with V-series Type Interfaces with Provision for Statistical Multiplexing.

27. CCITT Recommendation X.25, Interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Circuit.

28. CCITT Recommendation X.31, Support of Packet Mode Terminal Equipment by an ISDN.

NIUF (NIUF documents can be obtained by contacting: NIUF administrator, NIST, Bldg. 223, Room B364, Gaithersburg, MD 20899.

1. NIU 89-101, Implementation Agreement of the North American ISDN User's Forum, Basic Access Interface for Use on Metallic Loops for Application on the Network Side of the NT-Layer 1 Specification, 1989.

2. NIU 89-105, Implementation Agreement of the North American ISDN User's Forum, Basic Access Interface at Sand T Reference Points-Layer I Specification, 1989.

3. NIU 89-210, Implementation Agreement of the North American ISDN User's Forum, Data Link Layer Signalling Specification for Application at the User-Network Interface, 1989.

4. NIU 90-301, Implementation Agreement of the North American ISDN User's Forum, Layer 3 Signalling Specification for the Minimal Set of Circuit Switched Bearer Services for the ISDN Basic Rate Interface/Class I, 1990.

5. NIU 90-302, Implementation Agreement of the North American ISDN User's Forum, Layer 3 Signalling Specification for the Minimal Set of Circuit Switched Bearer Services for the ISDN Primary Rate Interface/Class II, 1990.

6. NIU 90-311, Implementation Agreement of the North American ISDN Users' Forum, Generic Procedures for the Control of ISDN Supplementary Basic Rate Interface/Class I, 1990.

7. NIU 89-320, Implementation Agreement of the North American ISDN Users' Forum, Packet Switched Call Control Procedures, 1989.

8. NIU 90-002 (NIU/IIW/ICOT/90-40), Integrated Services Digital Network (ISDN) Conformance Testing, Layer I Basic Rate SIT Interface, User Side, 1990.

9. NIU 91-001, Implementation Agreement of the North American ISDN Users' Forum, Circuit Mode Data Terminal Adaption, 1990.

10. NIU 91-006 (NIU/IIW/ICOT/90-60), Integrated Services Digital Network (ISDN) Conformance Testing, Layer I Basic Rate U Interface, User Side, 1990.

11. NIU 91-007 (N1U/IIW/ICOT/ACT23/91-22.2 V 1.2), Integrated Services Digital Network (ISDN) Conformance Testing, Layer 2 Basic Rate Interface, Link Access Procedure, D-channel (LAPD), User Side.

12. NIU 91-009 (N1U/IIW/ICOT/ACT23/91-10.3 R4), Integrated Services Digital Network (ISDN) Conformance Testing, Layer 3 Basic Call Control Procedures, Basic Rate Interface/Class L User Side.

13. NIU 421-93 (N1U/IIW/ICOT/ACT23/93-8.3R2 V 1.5), Integrated Services Digital Network (ISDN) Conformance Testing, Layer 3 Basic Call Control Procedures, Primary Rate Interface/Class IL User Side.

6. ADDITIONAL REFERENCES

The following references are indirectly referenced by "pointer" documents listed in this FIPS. The mapping to the pointer document is provided, as well. These references are included for information.

American National Standards Institute (ANSI documents can be obtained by contacting the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.)

ANS X3.100-1989, Interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DEC) for Operation with Packet Switched Data Networks (PSDN) or Between Two DTE's, by Dedicated Circuit, Referenced by FIPS 100-1.

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CCITT Recommendation Q.932, ISDN User-Network Interface-Layer 3-Generic Procedures for the Control of ISDN Supplementary Services, Referenced by ANSI T1.610.

CCITT X.2, International Data Transmission Services and Optional User Facilities in Public Data Networks and ISDNs, Referenced by FIPS-100-1.

APPENDICES

NOTE: Appendices A, B, and C describe the current status of the NIUF's ongoing effort to develop Implementation Agreements and conformance testing and requirements. These appendices are for information only, and are not part of this Federal Information Processing Standard. Appendix D defines the Implementation Agreement for Circuit Mode Data Terminal Adaption, and is a part of this FIPS.

Appendix A Additional Protocol Specifications To Be Considered

A.1 Implementation Agreements for ISDN Layer 1 Primary Rate Interface at the S, T or U reference point are being developed based on ANS T1.408-1990 [ANSI 2].

A.2 Implementation Agreements for Layer 3-Circuit Switched Call Control Procedures-Basic Call Control Procedures for Class I PRI will be based on ANS T1.607 [ANSI 8].

A.3 Implementation Agreements for Layer 3-Circuit Switched Call Control Procedures-Basic Call Control Procedures for Class II BRI will be based on ANS T1.607 [ANSI 8].

Appendix B Additional Services Specifications To Be Considered

B.1 Bearer Services

B.1.1 Implementation Agreements for Layer 3-7 kHz Audio (Multi-Use Bearer Capability) will be based on CCITT Recommendation Q.931 [CCITT 24].

B.2 Supplementary Services

The ISDN supplementary services specifications define the requirements of the supplementary services provided by an ISDN. The specifications identify the characteristics and attributes of a supplementary service (the ANSI specifications for a supplementary service include three parts: the service description, Specification and Description Language (SDL) definition, and service/protocol procedures). The NIUF has included the following supplementary services in their work plan: Call Waiting, Call Hold, Calling Line ID, Call Forwarding, User-to-User Signalling, Multi-Level Precedence and Preemption (MLPP), Call Completion to a Busy Subscriber (CCBS), Message Waiting Indicator Control and Notification, Conference Calling, and Hotline.

B.2.1 The Implementation Agreements for circuit mode supplementary services will be based on ANS T1.613 [ANSI 12], other relevant ANS documents as they become stable, CCITT Recommendations 1.251-1989 through CCITT 1.256-1989 [CCITT 2, 3, 4, 5, 6, 7], and corresponding completed NIUF Implementation Agreements.

Appendix C Additional Conformance Testing and Requirements To Be Considered

C.1 Physical Layer Test Specifications

Layer 1-Physical Layer-The BRI SIT interface test specification covers testing of functional, electrical, and mechanical characteristics of devices including TE1, TA, and NT's on the user-side. The tests include verification of framing, line bit rate, relative bit positions, D-channel access control, checking of jitter and phase, impedance, pulse shape and amplitude, pulse balance, receiver/transmitter performance, and power feeding and consumption. The BRI U interface tests include start-up procedures, pulse characteristics, impedance, jitter, frame structure, and M-channel bit functions.

Part 3: Primary Rate Interface, User Side will describe a set of test specifications which shall be implemented to verify equipment implementation conformance to the ISDN Physical Layer Primary Access at the S, T, and U interface, as defined in ANS T1.408-1990 [ANSI 2] and the corresponding NIUF Implementation Agreement.

C.2 Data Link Layer Test Specifications

Layer 2-Data Link Layer covers the protocol states defined in ANSI T1.602-1989 [ANSI 4] and the CCITT Recommendation Q.921 [CCITT 22]. For each state, three types of tests are specified: valid tests which cover the exchange of valid frames; inopportune tests which check the IUT's response to correctly formatted frames received in an unexpected state, and the invalid tests which verify the IUT's error recovery procedures upon receiving an incorrectly formatted frame.

Part 2: Primary Rate Interface, User Side will define the abstract test specifications which shall be implemented to verify equipment implementation conformance to the Layer 2 of an ISDN at the user-network interface, for the PRI access arrangements, as defined in ANS T1.602-1989 [ANSI 4] and NIU 89-210 [NIST 1, NIUF 3].

C.3 Network Layer Test Specifications

Layer 3-Network Access Layer will be based on ANSI T1.607 [ANSI 8] and CCITT Recommendation Q.931 [CCITT 24] and cover the D-channel operations for user-side states in the following functional areas: call setup from user and network, call clearing from user and network, and error recovery mechanisms (invalid information element and missing mandatory information element). As in the Layer 2 test suites, valid, inopportune, and invalid tests will be performed. Note that the operations of the B channels will not be covered in these tests.

Part 3: Packet Switched Call Control will define the abstract test specifications which shall be implemented to verify equipment implementation conformance to the Layer 3 of an ISDN at the user-network interface for the Packet Switched Call

Control Procedures, as defined by ANS T1.608-1990 [ANSI 9], NIU 89-320 [NIST 1, NIUF 7], and other corresponding NIUF Implementation Agreements.

C.4 Additional Test Specifications

Supplementary services will define the abstract test specifications to verify implementation conformance to the supplementary services at the user-network interface, as defined in ANS T1.610 [ANSI 10], NIU 90-311 [NIST 1, NIUF 6], and other appropriate ANS documents and their corresponding NIUF Implementation Agreements.

Packet Mode Bearer Services Control Procedures will define the abstract test specifications to verify implementation conformance to the Packet Mode Bearer Services Control Procedures.

Terminal Adaption will define the abstract test specifications to verify equipment implementation conformance to the ISDN Circuit Mode Data Terminal Adaption using Statistical Multiplexing, as defined by ANS T1.612-1990 [ANSI 11] and the corresponding NIUF Implementation Agreement.

Appendix D Implementation Agreement for Circuit Mode Data Terminal Adaption

The Circuit Mode Data Terminal Adaption IAs define the R reference point requirements when circuit-switched connections are provided by an ISDN. The IAs were developed in the Terminal Adaption Expert Working Group of the IIW.

The IA (NIU 91-001, [NIUF 9]) for the circuit mode terminal adaptor states: the following agreements are made with respect to ANS T1.612-1990 [ANSI 11]. (ANS T1.612 is based upon the CCITT Recommendation V.120, [CCITT 26].)

- Terminal Adapters shall support the use of the Low Layer Compatibility Information Element (LLC). The calling TA will be capable of including the LLC in the SETUP MESSAGE.

If the called TA does not receive the LLC, it shall attempt to operate in accordance with user established parameter values.

- Since link verification is not mandatory in Unacknowledged Information Transfer Mode, Terminal Adapters supporting but not requiring link verification must be able to proceed with operation in the event that they can not verify the link.

For Category I devices, the default operation shall be to attempt link verification, and enter the data transfer phase if link verification is unsuccessful.

For Category II devices, the default operation shall be to attempt link verification for I-Frame mode. If Link verification fails, the device shall fall back to

Unnumbered Information (VI) frame mode and attempt link verification. If that verification fails, the device shall move to the data transfer phase.

- V.120 terminal adapters should not resend the last I-frame transmitted as a poll upon expiry of TIOO (although they must respond appropriately if they receive an I-frame poll).
- For each V.120 mode of operation (from among Asynchronous Mode, Synchronous Mode, and Bit Transparent Mode) supported by a particular V.120 terminal adapter, the terminal adapter shall belong to one of two categories of equipment:

-Category I equipment which supports unacknowledged information transfer only.

-Category II equipment supports both unacknowledged information transfer and acknowledged information transfer.

A Category I terminal adapter must support the V.120 protocol, so that it must respond appropriately to an attempt by its peer to establish multiple frame operation. Category I equipment must respond to a received Set Asynchronous Balanced Mode Extended (SABME) with a Disconnected Mode (DM) with F bit matching the value of the P bit in the received SABME (which should be t '1').

The default action for Category II equipment that receives a DM in response to a transmitted SABME should be to fall back to unacknowledged information transfer. It is permissible to provide the user the ability to configure the terminal adapter to take actions other than the default in this circumstance, e.g., resending the SABME, or releasing the call.

Appendix E Glossary

E.1 Abstract test suite. A complete set of independent, but related, test cases which specify the actions required to achieve specific test purposes. They are specified at the level of abstraction appropriate for their test methodology. The abstract test suites specified in this FIPS are used for defining the conformance testing requirements.

E.2 Acquisition authority. An individual or team who, under Federal law and acquisition regulations, has the authority to enter into, administer, and/or terminate a government contract.

E.3 Bearer service. A type of telecommunications service that provides the capability for the transmission of signals between user-network interfaces.

E.4 Circuit switching. A technique of switching calls that provides a dedicated path between users. The telephone lines, switch connections, and other facilities are allocated on an exclusive basis for the duration of the call.

E.5 Conformance testing. The process of determining whether an implementation complies with the specification of a standard.

E.6 Customer Premise Equipment (CPE). Any apparatus that is physically located on the customer's property, as opposed to being housed in the telephone company's central office or elsewhere in the network. Examples include terminal equipment, ISDN terminal adapters, telephone sets, and network termination equipment. PBXs are considered CPE equipment in this FIPS.

E.7 Implementation Agreements. The Implementation Agreements in this FIPS refer to technical agreements reached in the North American ISDN Users' Forum.

E.8 Interoperability testing. The connection of various pieces of equipment to determine whether they work properly with each other.

E.9 LAPD. Link Access Procedure on the D-channel, the layer 2 protocol specified in CCITT Recommendation Q.921.

E.10 Packet switching. A technique in which a message is broken into smaller units, called packets, which may be individually addressed and routed through the network.

E.11 Supplementary service modifies or supplements a basic telecommunication service. Examples of supplementary services include Call Waiting, Call Forwarding, and Call Hold.

E.12 Terminal adaption. A protocol which allows non-ISDN terminal equipment to access public and private ISDNs and services by accommodating the lower speeds of the non-ISDN equipment (rate adaption).

E.13 User-network interface. The interface between the terminal equipment and the network equipment at which the access protocols apply.

E.14 User-to-user signaling. This allows users to exchange information over the signaling channel.

E.15 Virtual circuit. In packet switching, network facilities that appear to users as an end-to-end circuit, but are, in fact, a dynamically variable connection in which sequential packets may be routed differently during the course of the connection.

ANS American National Standard
ANSI American National Standards Institute
BRI Basic Rate Interface
CCBS Call completion to a busy subscriber
CCITT International Telegraph and Telephone Consultative Committee
CPE Customer premises equipment
DCE Data Circuit-Terminating Equipment
DM Disconnected Mode
DSSI Digital Subscriber Signaling System 1
DTE Data Terminal Equipment
ECSA Exchange Carriers Standards Association, Inc.
ET Exchange Termination
FIPS Federal Information Processing Standard
GOSIP Government Open Systems Interconnection Profile Implementation Agreements
IA Implementation Agreements
ICOT ISDN Conformance Test working group
IIW ISDN Implementors' Workshop
ISDN Integrated Services Digital Network
ISO International Organization for Standardization
IUT Implementation Under Test
IUW ISDN Users' Workshop
kbps Kilobits per second
kHz kiloHertz
LAPB Link Access Procedure Balanced
LAPD Link Access Procedure on the D-Channel
LLC Low Layer Compatibility
MLPP Multilevel precedence and preemption
NIST National Institute of Standards and Technology
NIUF North American ISDN Users' Forum
NT Network Termination
NT1 Network Termination 1
NT2 Network Termination 2
OIW OSI Implementors' Workshop
OSI Open Systems Interconnection
PBX Private Branch Exchange
PLP Packet Layer Protocol
PRI Primary Rate Interface
SABME Set Asynchronous Balanced Mode Extended
SDL Specification and Description Language
TA Terminal Adaptor
TE Terminal Equipment
TE1 ISDN Terminal
TE2 Non-ISDN Terminal
TEI Terminal Equipment Identifier
UI Unnumbered Information